# Deep Space Exploration Priorities

"…Human and robotic space exploration missions will land the first woman and person of color on the Moon, advance a robust cislunar ecosystem, continue to leverage human presence in low-Earth orbit to enable people to live and work safely in space, and prepare for future missions to Mars and beyond."

— The White House U.S Space Priorities Framework, Dec 2021
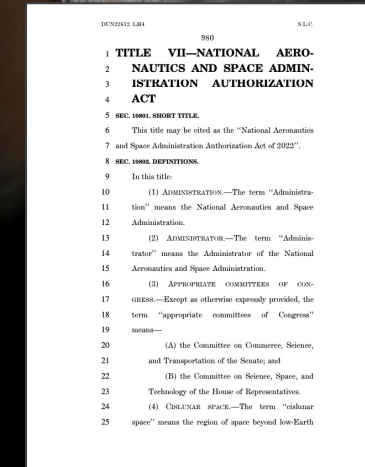

Space Policy Directive-1
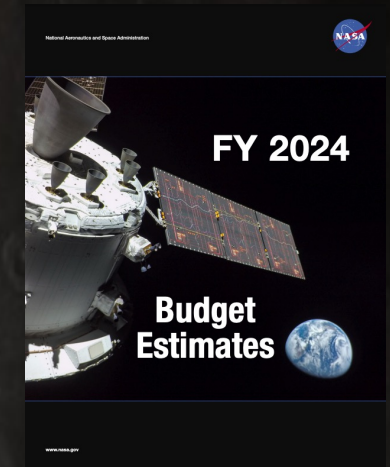December 2017
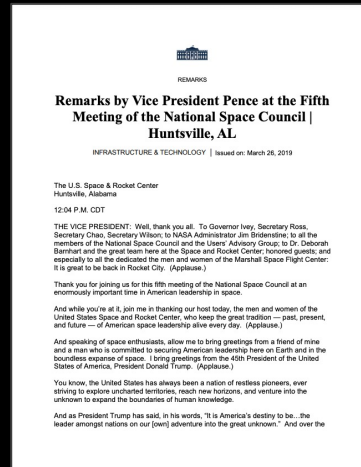
National Space Council
March 2019

Space Priorities Framework
December 2021

NASA Strategic Plan
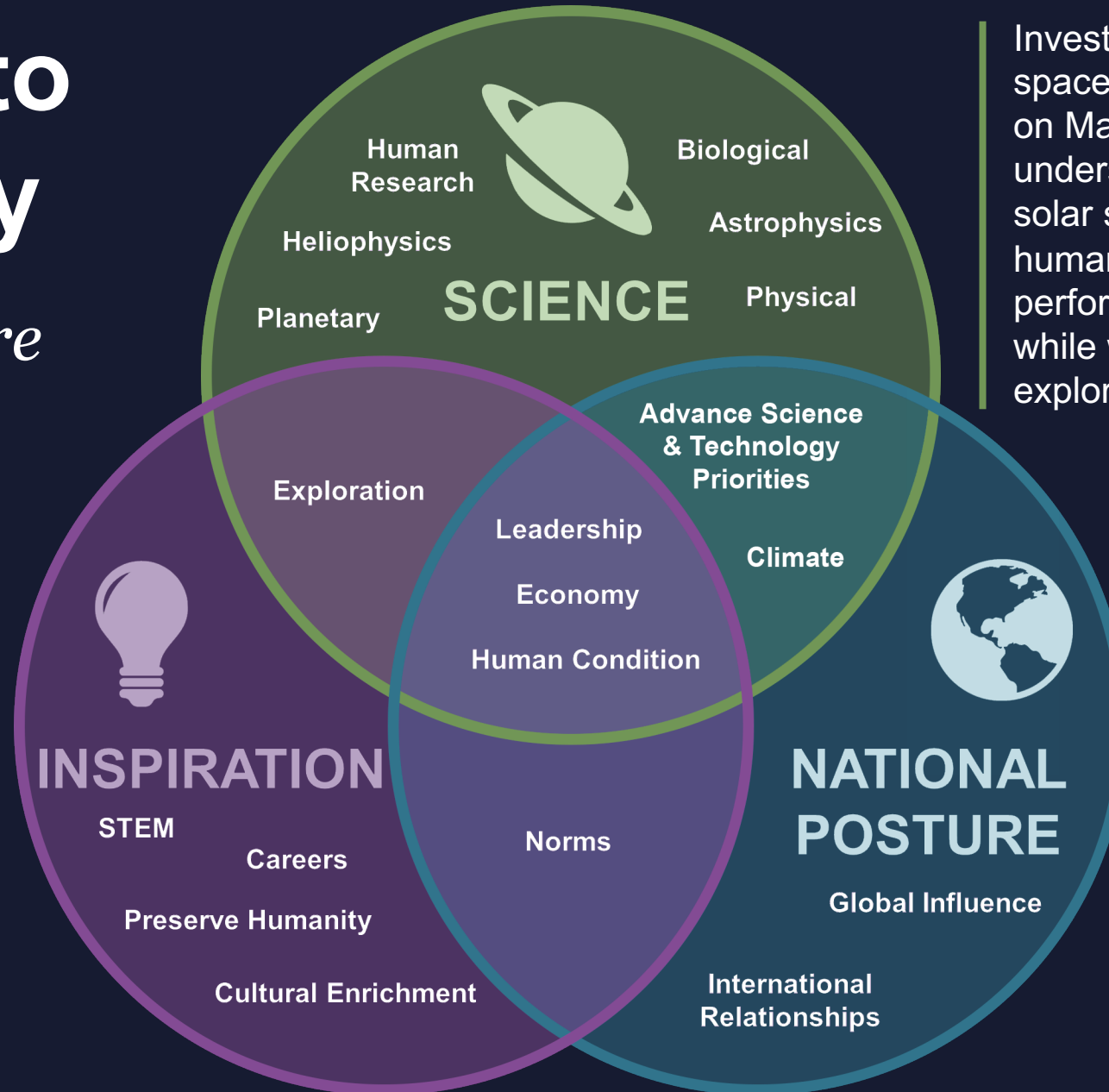March 2022

NASA Authorization Act
July 2022

President's Budget Request
March 2023

Benefits to Humanity
Why We Explore

SCIENCE
- Human Research
- Heliophysics
- Planetary
- Biological
- Astrophysics
- Physical

INSPIRATION
- STEM
- Careers
- Preserve Humanity
- Cultural Enrichment

NATIONAL POSTURE
- Global Influence
- International Relationships

Exploration

Advance Science & Technology Priorities

Climate

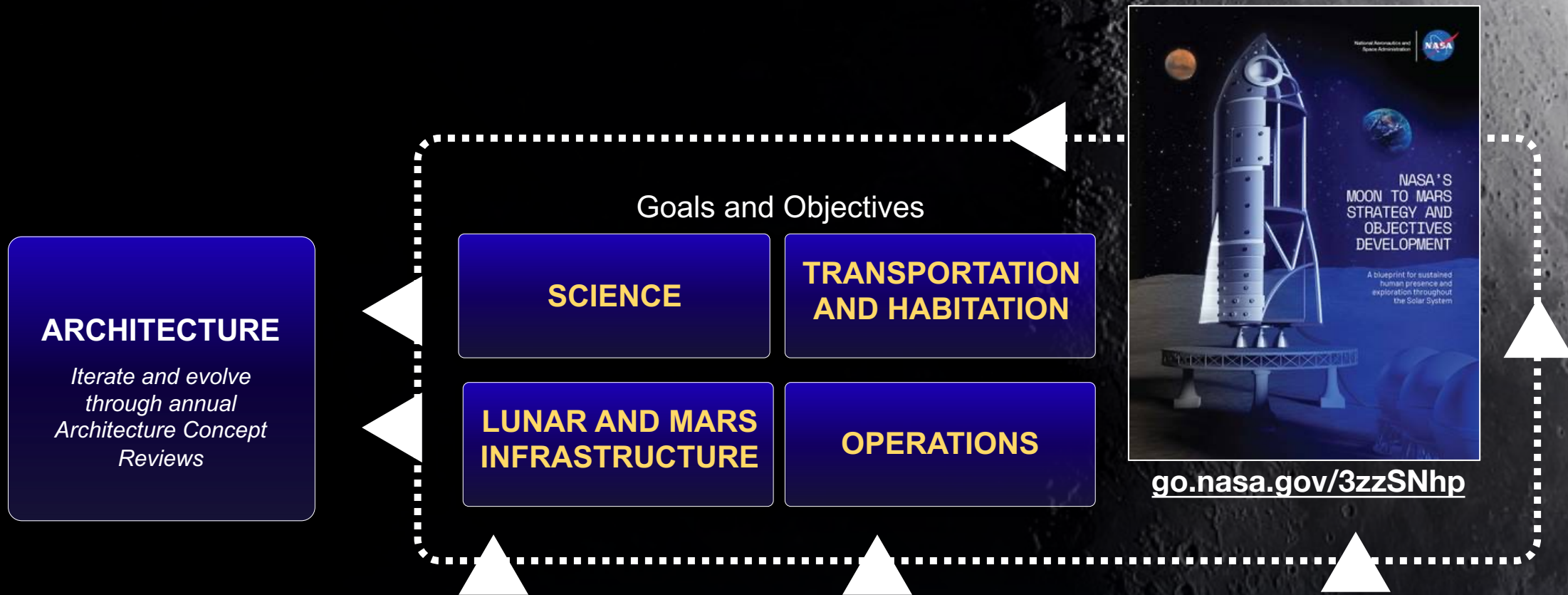Leadership

Economy

Human Condition

Norms

Investigations in deep space, on the Moon, and on Mars will enhance our understanding of the solar system, Earth, the human body, and how to perform new operations while we are out there exploring.

Accepting audacious challenges and succeeding through perseverance and tenacity in the face of adversity motivates current and future generations to dare mighty things.

What we choose to do, how we do those things, and who we do them with greatly impacts our place in the world today, our quality of life, and our possibilities for the future.

NASA Architecture Concept Review 2022

3

NASA's Moon to Mars Strategy and Objectives

A blueprint for future human exploration (Architecting from the Right)

ARCHITECTURE

Iterate and evolve through annual Architecture Concept Reviews

Goals and Objectives

SCIENCE

TRANSPORTATION AND HABITATION

LUNAR AND MARS INFRASTRUCTURE

OPERATIONS

NASA'S MOON TO MARS STRATEGY AND OBJECTIVES DEVELOPMENT

A blueprint for sustained human presence and exploration throughout the Solar System
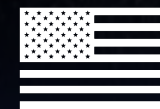
go.nasa.gov/3zzSNhp

Requested feedback on these objectives in summer 2022 from the following key stakeholders:

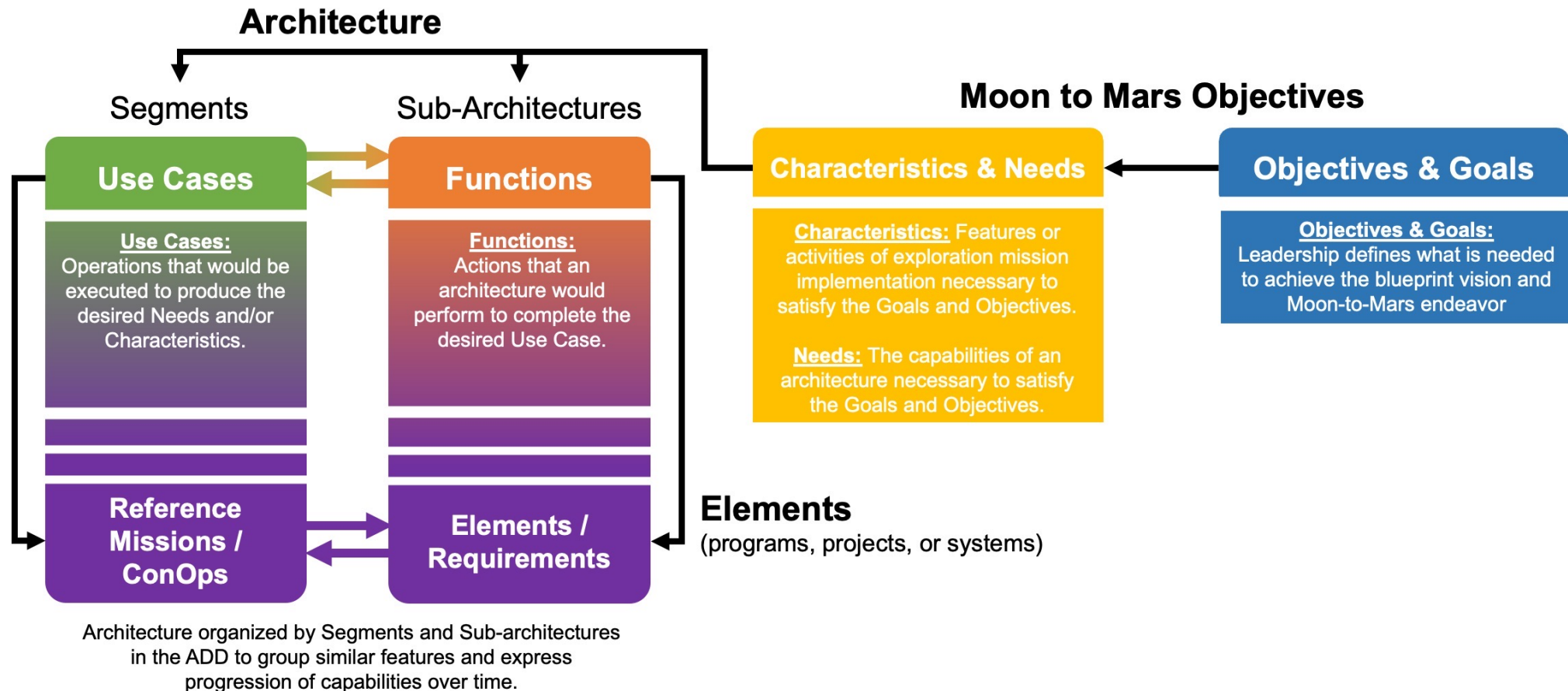NASA workforce: our greatest asset

International partners: our key current and future, anticipated collaborators

U.S. industry, academia, DOE, NIH, NSF, etc.: our national leaders in space research and capabilities

Architecting from the Right

Architecture

Segments | Sub-Architectures

Use Cases

Use Cases: Operations that would be executed to produce the desired Needs and/or Characteristics.

Functions

Functions: Actions that an architecture would perform to complete the desired Use Case.

Moon to Mars Objectives

Characteristics & Needs

Characteristics: Features or activities of exploration mission implementation necessary to satisfy the Goals and Objectives.

Needs: The capabilities of an architecture necessary to satisfy the Goals and Objectives.

Objectives & Goals

Objectives & Goals: Leadership defines what is needed to achieve the blueprint vision and Moon-to-Mars endeavor

Reference Missions / ConOps

Elements / Requirements

Elements (programs, projects, or systems)

Architecture organized by Segments and Sub-architectures in the ADD to group similar features and express progression of capabilities over time.

The Architecture process requires a decomposition of Moon to Mars Objectives to element functions and mission use cases to complete the process of "architecting from the right." This establishes the relationship of executing programs and projects to the driving goals and objectives.

Integrating Human and Supporting Robotic Science Needs

- ACR22 and associated products were focused on the Human Lunar Return segment of the architecture
    - Included related SOMD systems, SMD robotic missions, STMD technology demonstrations, and ARMD activities
- The Moon to Mars Architecture Definition Document (ADD) includes use cases, functions, and reference missions for uncrewed periods of operations in lunar orbit and on the surface

Moon to Mars Objectives
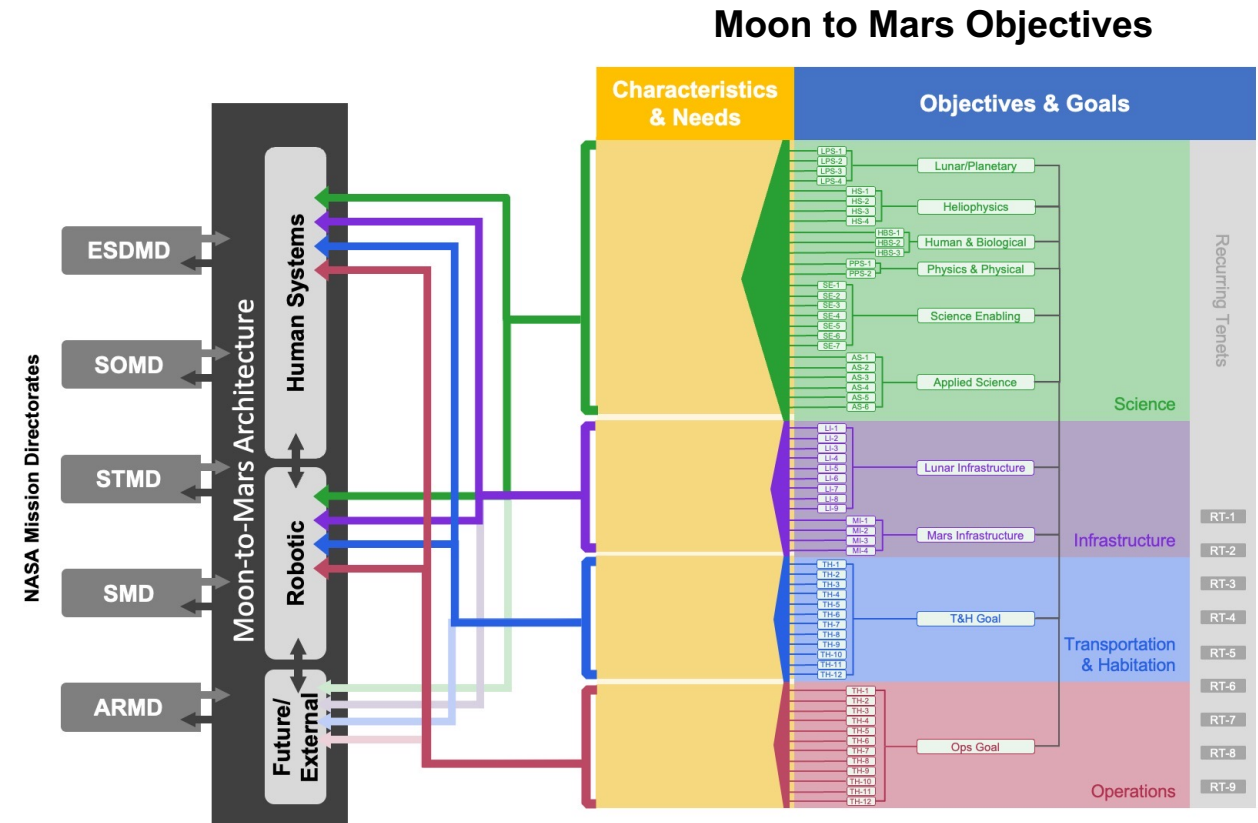
Architecture Concept Review

The purpose of an Architecture Concept Review (ACR) is to help unify the agency, promote advocacy for the architecture, and generate inputs from across NASA.

- The specific purpose of the Architecture Concept Review 22 (ACR22) was to:
  - Concur on the newly established yearly ACR process
  - Concur on disposition of key issues from ESDMD-001 Moon to Mars (M2M) Architecture Definition Document (ADD) Change Request
    - Human Lunar Return segment focus
  - Concur on priority tasks for the next ACR

ARCHITECTURE CONCEPT REVIEW (ACR22)
Participation included representation from Mission Directorates, Agency Leadership, NASA Centers, Tech Authorities, ESDMD Leadership, Program Managers, and the Architecture Team

Future ACRs will be conducted annually in November to continue refining the architecture based on evolving policy, budget, partner contributions, and development schedules. Annual ACRs shifted to align with the NASA budget cycle.

Segments and Sub-architectures

Segment: A portion of the architecture, identified by one or more notional missions or integrated use cases, illustrating the interaction, relationships, and connections of the sub-architectures through progressively increasing operational complexity and objective satisfaction.

Human Lunar Return

Initial capabilities, systems, and operations necessary to re-establish human presence and initial utilization (science, etc.) on and around the Moon.

Focus for ACR 22

Foundational Exploration

Expansion of lunar capabilities, systems, and operations supporting complex orbital and surface missions to conduct utilization (science, etc.) and Mars forward precursor missions.

Sustained Lunar Evolution

Enabling capabilities, systems, and operations to support regional and global utilization (science, etc.), economic opportunity, and a steady cadence of human presence on and around the Moon.
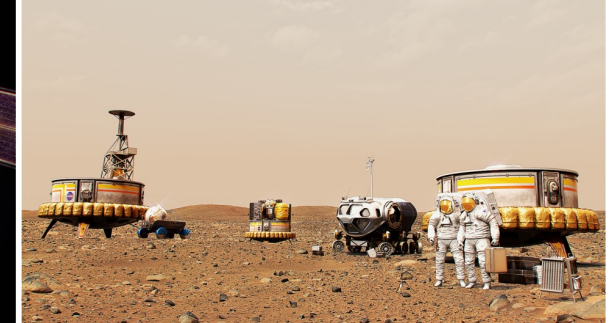
Humans to Mars

Initial capabilities, systems, and operations necessary to establish human presence and initial utilization (science, etc.) on Mars and continued exploration.

Focus for ACR 23

Sub-architecture: A group of tightly-coupled systems, functions, and capabilities that perform together to accomplish architecture objectives.

Communication, Positioning, Navigation, and Timing • Habitation • Human Systems • Logistics • Mobility Systems • Power • Transportation • Utilization Systems

Human Lunar Return Segment
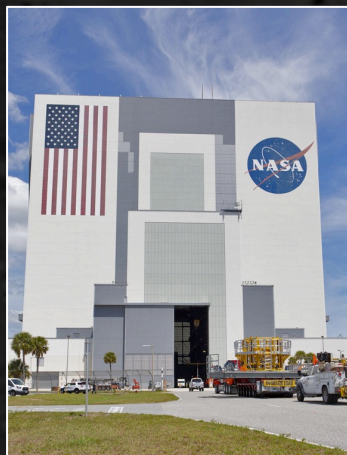
EXPLORATION GROUND SYSTEMS

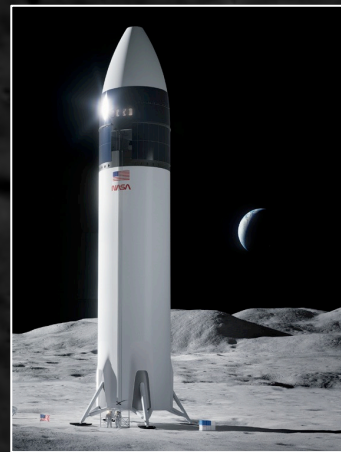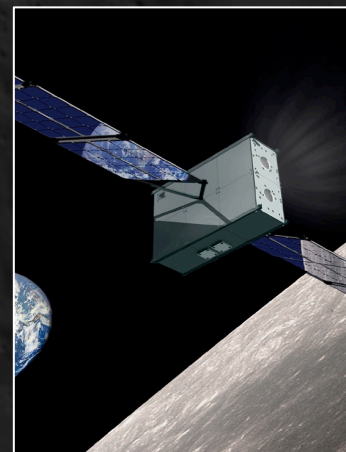ORION SPACECRAFT

SPACE LAUNCH SYSTEM

GATEWAY

DEEP SPACE LOGISTICS

xEVA Systems

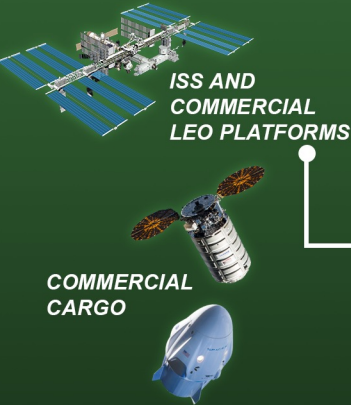HUMAN LANDING SYSTEM

COMM, POSITIONING, NAV, TIMING (CPNT)

COMMERCIAL LUNAR PAYLOAD SERVICES

MOON TO MARS CAMPAIGN SEGMENTS

ELEMENTS SHOWN BEYOND *HUMAN LUNAR RETURN* ARE NOTIONAL

LEO AND EARTH ANALOGS

SUSTAINED LUNAR EVOLUTION

HUMAN LUNAR RETURN

FOUNDATIONAL EXPLORATION

HUMANS TO MARS *MODEST FIRST MISSION OF THE TRADE SPACE SHOWN*

SLS BLOCK 1   ORION   NEAR-TERM ARTEMIS MISSIONS   SLS BLOCK 1B

SLS BLOCK 2

ISS AND COMMERCIAL LEO PLATFORMS

COMMERCIAL CARGO

GATEWAY

Increased Crew Size & Longer Durations in Micro-gravity

TRANSIT HABITAT AND MARS TRANSIT

COMMUNICATIONS RELAYS

SURFACE HABITAT

LOGISTICS LANDER

Nuclear Surface Power

HUMAN LANDING SYSTEM

MARS ASCENT VEHICLE

Habitation Systems

PRESSURIZED ROVER

Partial Gravity Operations

PRESSURIZED ROVER

Mobile Expedition Duration / Mobile Exploration Range
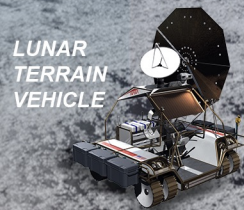
LUNAR TERRAIN VEHICLE

In-Situ Resource Utilization

MARS TERRAIN VEHICLE
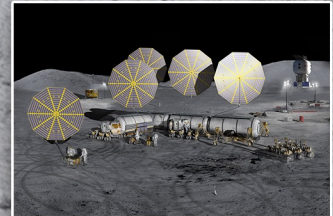
Autonomous Robotics Systems & Contingency Crew Transportation

Sustained Lunar Evolution

20230223
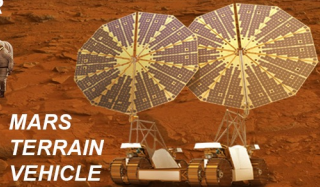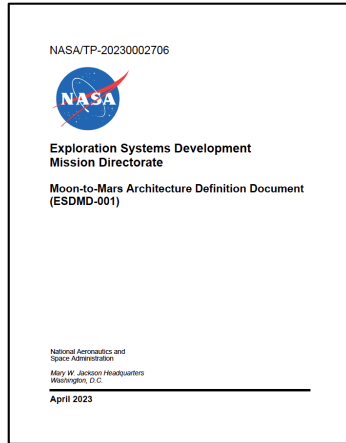
ACR Public Products
## Available at www.nasa.gov/MoonToMarsArchitecture

Architecture Definition Document
- **Length:** 150 pages
- **Purpose:** detailed documentation of a snapshot of the human spaceflight architecture and exploration strategy
- **Audience:** highly technical – NASA, industry, international partners, committee staffers
- **Publication**: NASA Technical Reports Server
- **Update cadence:** Annual ACRs

Moon to Mars Architecture Summary
- **Length:** 18 pages
- **Audience:** technically informed – Advisory, legislative, investigative, auditing organizations
- **Purpose:** high-level documentation of M2M architecture and exploration strategy
- **Publication:** nasa.gov
- **Update cadence:** as needed
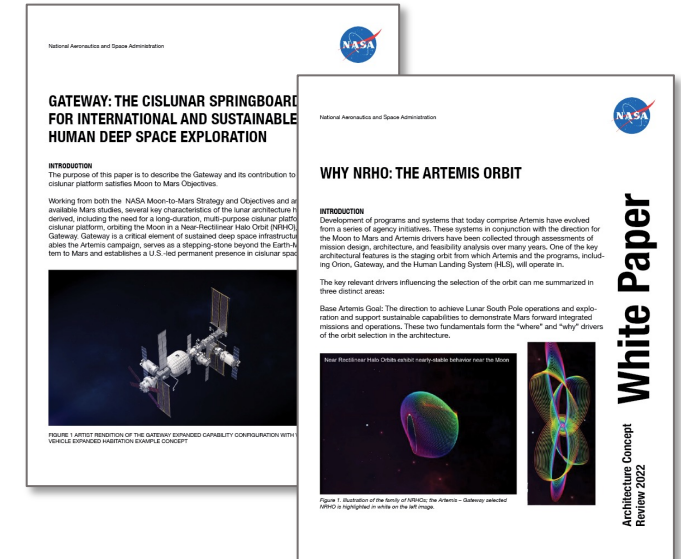
White Papers
- **Length:** 4-6 pages each
- **Purpose:** document architecture study details on frequently discussed topics
- **Audience:** technically informed – industry, international partners, staffers
- **Publication**: nasa.gov
- **Update cadence:** ACRs and as needed

Areas for Collaboration

The Moon to Mars architecture is flexible, and there are opportunities to contribute, creating opportunity.

POWER INFRASTRUCTURE AND DISTRIBUTION

COMMUNICATION AND NAVIGATION

LUNAR ENVIRONMENT MITIGATION

ROBOTICS AND MOBILITY

LOGISTICS

UTILIZATION OPERATIONS

LUNAR SAMPLING AND CURATION

HABITATION AND CREW HEALTH SYSTEMS

EXPLORATION SYSTEMS AND OPERATIONS ANALOG TESTING

Engagement and Feedback

Stakeholders provide input during existing interactions including: conference meetings, partner discussions, bi-laterals, etc.

NASA-led workshops planned summer of 2023, which are geared toward soliciting feedback on processes and documentation.

Partner professional society workshops provide additional opportunities for engagement.
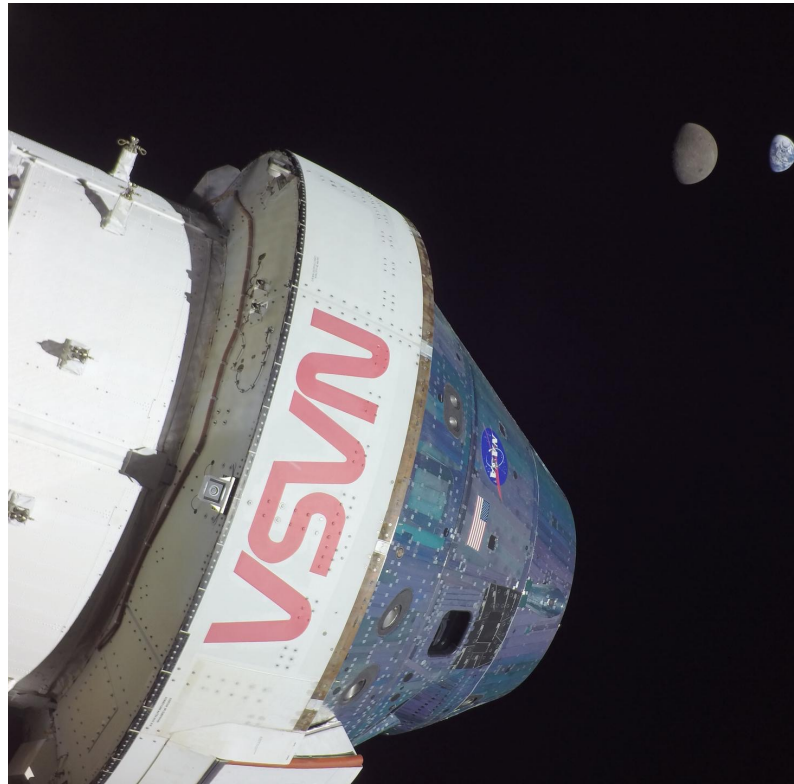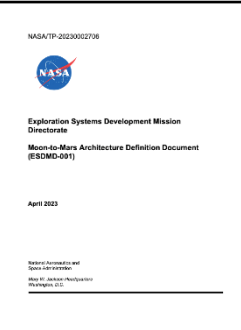
The Artemis Generation is Now!

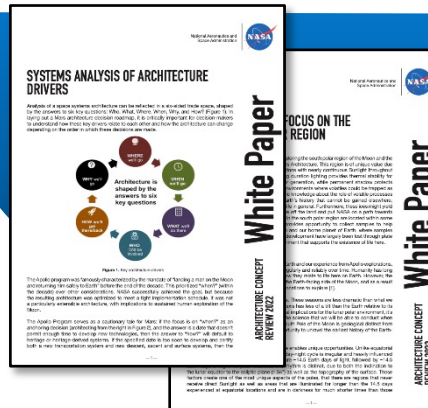# Architecture Concept Review Products

Architecture Definition Document
Detailed documentation of a snapshot of NASA's human spaceflight architecture and exploration strategy

Moon to Mars Architecture Summary
High-level overview of NASA's Moon to Mars architecture and exploration strategy

White Papers
Six papers on architecture study details for frequently discussed topics

www.nasa.gov/MoonToMarsArchitecture